GEORGIA INSTITUTE OF TECHNOLOGY

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. A-3085 DATE 10/9/81

Project Director: James L. Burson Sdmnd/Lab EDL/SHS

Sponsor: Iowa Power and Light

Type Agreement: Proposal Acceptance

Award Period: From 9/21/81 To 11/30/81 (Performance) 11/30/81 (Reports)

Sponsor Amount: $9,200 Contracted through:

Cost Sharing: n/a GTRI/~~GIT~~

Title: Industrial Hygiene Monitoring for Iowa Power & Light Co. Electric Generating Stations

ADMINISTRATIVE DATA

OCA Contact Faith G. Costello

1) Sponsor Technical Contact:

Mr. Lynn Wallis

2) Sponsor Admin/Contractual Matters:

Mr. Lynn Wallis
Iowa Power & Light Co.
823 Walnut Street
P.O. Box 657
Des Moines, Iowa 50303

Defense Priority Rating: N/A

Security Classification: N/A

RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with N/A

COMMENTS:

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FORM OCA 4-781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 1/5/82

Project Title: Industrial Hygiene Monitoring for Iowa Power and Light CO. Electric Generating Stations

Project No: A-3085

Project Director: James L. Burson

Sponsor: Iowa Power and Light

Effective Termination Date: 12/21/81

Clearance of Accounting Charges: 12/21/81

Grant/Contract Closeout Actions Remaining:

- [X] Final Invoice ~~and Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: EDL/SHS ~~(School~~/Laboratory)

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FORM OCA 10:731

INDUSTRIAL HYGIENE SURVEY
for
IOWA POWER AND LIGHT COMPANY
Des Moines, Iowa
December 10, 1981

Submitted by
GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Occupational Safety and Health Services
Atlanta, Georgia 30332

Project #A-3085

Table Of Contents

I. EXECUTIVE SUMMARY

Iowa Power and Light Company retained the Georgia Tech Engineering Experiment Station to conduct an Industrial Hygiene Survey of it's Des Moines Power Station and Council Bluffs Power Station. The purpose of the audit was twofold: (1) determine employee exposure to several potentially harmful chemical and physical agents identified during a previous industrial hygiene audit and subsequent surveys; and, (2) measure the effectiveness of certain engineering controls and/or work practices which have been implemented to reduce employee exposure to harmful substances or agents.

During the course of the survey, 110 total samples were collected for some sixteen different substances or agents; 97 samples to determine personal exposure to substances and 13 area samples to determine workplace concentrations of specific contaminants. The survey included the collection and analysis of samples for asbestos, noise, cyclohexylamine, hydrazine, chlorine, nitrogen dioxide, carbon monoxide, total nuisance dust, arsenic, manganese, iron, zinc, total respirable dust, crystalline silica, mercury, and welding fumes.

This report presents the results of the industrial hygiene survey, a discussion of the findings, and eight recommendations based on the results of this survey. There has been a general and consistent improvement in both occupational health awareness and the implementation of engineering controls and/or work procedures to eliminate or control employee exposure to potentially harmful substances or agents. Many of the recommendations presented address conditions or procedures which have previously been established, but which now need additional education of employees and emphasis by management.

II. INTRODUCTION

Iowa Power and Light Company retained the Georgia Tech Engineering Experiment Station to conduct an Industrial Hygiene Survey of its two power generating stations - Des Moines Power Station (DPS) and Council Bluffs Power Station (CBPS). The primary purpose of this periodic survey was to determine employee exposure to various potentially harmful chemical and physical agents identified in an industrial hygiene audit conducted in June 1979. In addition, this survey served to measure the effectiveness of certain engineering controls and/or work practices which have been implemented to reduce employee exposure to harmful substances or agents.

The survey was conducted at Des Moines Power Station on September 21-22, 1981 and at Council Bluffs Power Station on September 23-25, 1981. The field survey work was conducted by James L. Burson of the Georgia Tech Occupational Safety and Health Branch and Tom Shifflet of Iowa Power and Light Company, with assistance from Robin Fortney and David DeRoos of Iowa Power and Light Company. The survey included the collection of area samples for asbestos, cyclohexylamine, hydrazine, chlorine, nitrogen dioxide, and carbon monoxide. Samples were also collected to measure personal exposure to total nuisance dust, several metals in the dust, respirable coal dust, crystalline silica, asbestos, mercury, welding fumes and noise.

This report includes a discussion of the results and recommendations based upon the laboratory analysis of collected samples and personal observations of work practices and procedures. Appendix A contains a discussion of the sampling and analytical methods utilized. Appendix B summarizes the sampling results. Toxicological information concerning the contaminants monitored during this survey is presented in Appendix C; Appendix D summarizes requirements of the new noise regulation.

Monitoring was conducted during routine job functions performed by employees at the plants. In addition, several jobs were monitored which are not considered routine, but were being performed at the time of the survey. These included

manometer repair using mercury, electric arc welding, bagging insulation containing asbestos, and sandblasting. Monitoring was performed on the day shift each day; additionally, employee monitoring was performed on the evening shift on Thursday. The weather was clear with warm temperatures except for Thursday when there was scattered light showers during the morning. During the survey, units 6-10 and 7-11 were operating at DPS; at CPS Units 1, 2 and 3 were all operating.

DISCUSSION AND RECOMMENDATIONS

A. Noise

A total of thirty-four personal samples using noise dosimeters were taken to evaluate employee exposure to noise: nine measurements at DPS and 25 measurements at CPS. The Occupational Safety and Health regulation's permissible exposure limit (PEL) currently limits noise exposure to 90 dBA based on an 8-hour, time-weighted average (TWA). On August 22, 1981, these regulations were amended to establish an "action level" of 85 dBA based on an 8-hour, TWA. A summary of these noise regulations is presented in Appendix D. The new noise standard requires, among other things, that a comprehensive hearing conservation program be provided for all affected workers where their noise exposure equals or exceeds the action level of 85 dBA. The summary below presents a frequency distribution of the noise dosimetry measurements made during this survey in five decibel ranges.

Equivalent Exposure Range (dBA)	Number of Samples DPS	CPS	TOTAL
> 90	0	4	4
85 but 90	7	14	21
80 but 85	0	3	3
75 but 80	1	1	2
70 but 75	1	2	3
<70	0	1	1
TOTAL	9	25	34

None of the employees monitored at DPS received noise exposures in excess of 90 dBA for an eight-hour, time-weighted average (TWA). Four of the twenty-five employees (16%) monitored at CPS received noise exposures in excess of the PEL. As can be seen from the above, a significant number of employees monitored (62%) were exposed to noise below the permissible exposure limit but above the action level.

Hearing conservation programs have been instituted at both power stations however, employees were frequently observed in high noise areas without ear protection. This is an on-going problem which requires constant attention by all levels of supervision.

> RECOMMENDATION #1: Steps should be taken to insure that all employees working in areas of high noise wear approved hearing protectors.

A review comparison of noise exposures of the D-9 Cat operator at CPS revealed that noise exposure levels have increased over the past two years. In November 1979, noise dosimetry showed that the D-9 operator was exposed to noise of 87 dBA for an 8-hour, TWA. Measurements made during this survey showed a noise exposure of 93 dBA. In comparison, the D-9 operator at DPS was exposed to noise levels of 88 dBA. An examination of the cab indicated that deterioration of the seals and insulation contributed to this significant increase in noise exposure of the operator.

> RECOMMENDATION #2: The cab insulation of the D-9 Cat at CPS should be examined and replaced where deteriorated. Sound levels inside the cab and noise exposure of the operators should be periodically measured to determine the effectiveness of the acoustical insulation package in reducing noise.

B. Coal Dust and Crystalline Silica

Sixteen personal samples (7 at DPS and 9 at CPS) were taken to evaluate exposure to total respirable dust. The samples were also analyzed for crystalline silica content in order to calculate the appropriate PEL. All of the respirable dust monitoring was performed using coal handling personnel except for one measurement (RD-7, #7672) conducted during a sandblasting operation. All samples, taken during a wide variety of coal handling operations at both power stations, were below the IOSH PEL of 2.4 mg/m^3 for respirable coal dust. Likewise, analysis of the samples showed that all exposures were less than one-half the calculated PEL for crystalline silica.

One sample was taken during a sandblasting operation at DPS to measure total respirable dust and crystalline silica. Results indicated that the airborne concentration of total respirable dust was in excess IOSH PEL of 5.0 mg/m^3 for an 8-hour, TWA. The results also indicated that crystalline silica concentrations were over the calculated PEL of 0.20 mg/m^3. The high silica content (48%) of the sandblasting medium accounts for the very low PEL (0.20mg/m^3) in this case. Although the airborne concentration of total respirable dust and crystalline silica were above established limits and presented the possibility for an employee exposure in excess of the PEL, the employee wore a sandblasting hood which provided the necessary protection. Thus, the employee was not exposed to respirable dust or crystalline silica in excess of the permissible exposure limits.

Other maintenance employees were observed in relatively close proximity to the sandblasting operation. These employees did not wear respiratory protection although the dust occasionally was blown toward them.

RECOMMENDATION #3: Review need to use "silica sand" as a sandblasting medium for routine needs. There are several other sandblasting agents which are currently available that do not pose a significant health risk and which are suitable for most abrasive blasting operations. The silica sand currently used poses a problem not only during its use but as a source of fugitive dust for several days afterward as it is blown around by the wind and scattered by employees walking through it.

RECOMMENDATION #4: Establish procedures at both power station to periodically measure and record key air flow and pressure parameters associated with the coal handling ventilation systems. These measurements will assist maintenance personnel in determining the effectiveness of the system and allow them to determine when and where routine maintenance is needed.

C. Total Dust and Metals

A total of twenty personal samples were taken to evaluate employee exposure to total nuisance dust. (6 at DPS and 14 at CPS). Although the measuring of total dust is useful, it does not indicate exposures to specific contaminants in the dust. For this reason, after determining total weight of the samples, the samples were analyzed for content of four common metallic contaminants associated with coal and fly ash. The samples were analyzed for iron, manganese, arsenic, and zinc.

All of the samples, except two taken during welding, showed employee exposures less than the permissible exposure limit of 15mg/m^3 for nuisance dust and below the PEL for each of the metals analyzed. The highest total dust measurements were observed among the laborers, 9.11 mg/m^3 (TD-13, #7644) and 3.56 mg/m^3 (TD-14, #7709). The truck driver assigned to transporting fly ash from the collector to the pond at CPS received an 8-hour TWA exposure of 4.79 mg/m^3. All of these are below the established IOSH PEL.

The mechanic performing welding at CPS received exposures to welding fumes and metals well above established limits. The mechanic's exposures are summarized below:

		Total Fume	Iron	Manganese	Arsenic	Zinc
	IOSH PEL	15.0	10.0	5.0	0.0001	5.0
09-24-81	Welding Steel (25 min.)	62.8	15.6	2.7	0.0020	23.8
09-25-81	Welding Steel (16 min.)	109.4	28.6	3.9	0.0300	11.8

The welding was performed in a designated welding area in the Unit #3 maintenance shop at CPS. This area does not have a local exhaust to capture the welding fumes and exhaust them to the outside. There is a wall- mounted exhaust fan in the area, but observations (as well as exposure measurements) revealed it to be quite ineffective. In some cases, the existing fan would actually pull the fumes across the breathing zone of the welder and actually increase his exposure to the contaminants.

> RECOMMENDATION #5: A low-volume, high-velocity exhaust ventilation system on an articulating arm should be installed in the welding area at CPS. There are several "packaged" units available which are designed specifically for exhausting welding fumes.

D. Mercury

Monitoring was performed during a simulated repair of mercury manometers at both DPS and CPS. A total of three personal samples were colleced for mercury during the exercise. Results showed all exposures to below the IOSH PEL of 0.01 mg/m^3. Proper protective equipment and procedures were utilized during the handling of mercury. Adequate precautions were taken to contain and clean-up any mercury spilled.

E. Water Treatment Chemicals

All samples collected for the evaluation of airborne exposure to hydrazine, cyclohexylamine, and chlorine were area samples taken in close proximity to the chemicals, either in the storage/dispensing area or at the mix tanks. All samples for cyclohexylamine and hydrazine were well below the IOSH PEL for these compounds.

During the survey at DPS, the "changing" of hydrazine drums was observed in the dispensing area. Employees were observed to wear impervious clothing, gloves, and a face shield. However, during the change, approximately 1 pint of hydrazine was spilled to the floor. Less than adequate precautions and procedures were observed during clean-up of the spill.

RECOMMENDATION #6: Proper handling and clean-up of water treatment chemicals should be periodically reviewed with employees involved in this task. Personal hygiene and disposal of wastes should be a part of this review.

RECOMMENDATION #7: A make-up air vent should be installed in the chlorine house on the wall opposite the floor. The vent should have a weather louver installed in it for protection.

F. Combustion Gases

Samples for carbon monoxide and nitrogen dioxide were taken at both power stations to determine if potentially harmful concentrations of these gases were present near the boilers. Area samples were taken near burners at Units #10 and #11 at DPS and at Unit #1 at CPS. Nitrogen dioxide was not detected at any of the measurement locations. Only trace amounts of carbon monoxide were observed at one of the locations.

G. Asbestos

Three area and seven personal samples were taken for determination of airborne asbestos concentrations at the two power stations. The area samples near pipe insulation, did not show asbestos fibers present. Personal samples, taken during clean-up and bagging of asbestos likewise did not show any fibers present. A personal sample taken during removal of pipe insulation at CPS did not reveal an exposure to asbestos fibers.

Personel protective clothing used during the clean-up and bagging of asbestos waste and during removal of pipe insulation was adequate and the employees involved appeared to be conscientious of using disposable clothing and observing proper work procedures. Employees used 3M #8710 disposable respirators during asbestos work.

While it is recognized that the single-use type of air purifying respirator in use at the power stations carries an MSHA/NIOSH approval and certification for use against fibrosis producing dusts including asbestos, the companies attention is directed to the December 1980, issue of the American Industrial Hygiene Journal

which carries a reprint of a letter from NIOSH to all respirator manufacturers. Essentially NIOSH has taken the position that the use of such respirators as protection against a known carcinogen is questionable despite the issued approval number.

Two bulk samples of material were obtained at CPS for determination of form and content of asbestos. One sample was of pipe insulation from a steam line behind Units 1 & 2 control room at CPS. This insulation was found to contain 25% - 31% chrysotile asbestos. A second sample was of material which had fallen from the ceiling outside the plant manager's office in the Unit 1 & 2 office area. Material which appears to have been sprayed on the ceiling was delaminating and falling from the ceiling. Analysis showed this material to contain approximately 5% chrysotile asbestos.

> RECOMMENDATION #8: Additional material from the ceiling in the old office areas at CPS should be analyzed for asbestos content. This information along with accessibility, damage, employee exposure, and friability should be used to establish a plan to eliminate this potential hazard. Alternatives include removal, sealing, and isolation.

APPENDIX A

Sampling and Analytical Methods

Noise Dosimetry
Respirable Dust And Free Silica
Metals And Total Dust
Inorganic Mercury
Hydrazine
Cyclohexylamine
Chlorine
Nitrogen Dioxide
Carbon Monoxide
Asbestos (airborne)
Asbestos (bulk)

NOISE DOSIMETRY

Noise dosimetry studies of employee noise exposures were made using DuPont, Model D-376, Audio Dosimeters, set for a 90 dBA cutoff.

Sound levels reaching the employee were detected by a non-directional ceramic microphone worn on the shirt collar. This input is attenuated using the "A" weighting scale described in the American National Standards Institute S1.4-1971 "Type 2 Specification". If the microphone picks up any continuous sound over 115 dBA, it is recorded and stored for later inspection.

Next, noise below the cutoff level, 90 dBA, is removed on a continuous basis. The ratios of actual exposure to established limits at every sound level between 90 and 115 dBA are calculated and integrated with time to give the actual exposure during the workday as a percentage of that permitted by the regulations.

Data storage is accomplished by means of an electroplating reaction that occurs within an integrating memory cell. The information is stored in the cell until it is retrieved in a DuPont, Model R-225 readout instrument by reversing the electroplating reaction. The memory cell is automatically cleaned for reuse as the exposure information is retrieved.

Prior to use, the Audio Dosimeter battery is checked with an internal battery check and calibrated at two sound levels with a DuPont, Model C-114, calibrator.

RESPIRABLE DUST AND FREE SILICA

Samples to be analyzed for "respirable" dust and crystalline free silica were collected by using battery-powered, portable pumps to draw air at a nominal flowrate of 1.7 liters per minute through 37-millimeter diameter polycarbonate membrane filters, 0.8 micrometer pore size contained in cassettes preceded by 10-millimeter nylon cyclone particle size selectors.

The mass of particulate matter collected on each filter was determined gravimetrically as the difference between the weights of the filters before and after sampling, using a five-place analytical balance in a temperature-and-humidity controlled environment. The samples then were transferred into beakers containing small volumes of a surfactant solution (5% Triton X-100 in distilled water) and placed in an ultrasonic vibrator bath to dislodge particulate matter from the filter matrices. The resultant suspensions then were passed through 25-millimeter diameter polycarbonate membrane filters, 0.4 micrometer pore size, using vacuum filtration to achieve uniform sample deposits. After drying, the filters were placed on the rotating sample state of an X-ray diffractometer equipped with data control and data processor to provide both digital and graphic indication of detector responses. The masses of crystalline free silica (quartz, cristobalite, and tridymite) on the samples were determined by comparison of the relative responses, at the appropriate diffraction angles, of the scintillation detector to the copper K a-illuminated samples with the responses at the same angles to standards prepared by uniform deposition of known amounts of the pure materials on the same filter matrix.

Results of the gravimetric and X-ray diffraction analyses, which included any necessary corrections for blank determinations run in parallel with the analyses, were used to compute the "% SiO_2" (percent free silica) in each sample; the resultant figure then was used to compute the eight-hour, time-weighted average limit for exposure to the particulate matter collected in that sample. Results of the gravimetric analyses were used in conjunction with sampling data (measured flowrates and durations of sampling) to calculate concentrations of airborne particulate matter collected on the samples, expressed in milligrams of particulate matter per cubic meter of air (mg/m3).

METALS AND TOTAL DUST

Samples to be analyzed for metallic elements and total dust were collected by drawing air at measured flowrates through cassetted cellulose ester membrane filters using battery-powered, portable pumps.

The mass of particulate matter collected on each filter was determined gravimetrically in the laboratory as the difference between the tare weight of the filter and the weight of the filter after sampling and equilibration to balance room conditions.

For the analyses of metals, the filter matrices were destroyed by ashing with concentrated nitric acid, and the residues dissolved in either dilute hydrochloric acid or dilute nitric acid. The resultant solutions were aspirated into the flame of an atomic absorption spectrophotometer equipped with the appropriate hollow-cathode lamps. After scattered light corrections, the absorbances at the analytical wavelengths of the samples were compared to the absorbances to aqueous standard solutions containing known amounts of the metal analytes. Analytical results, which include any necessary corrections for blank and recovery determinations run in parallel with the analyses, were used in conjunction with the measured flowrates and sampling durations to calculate the concentrations of airborne analyte species, expressed in units of milligrams of analyte per cubic meter of air (mg/m^3).

INORGANIC MERCURY

Sampling for mercury was conducted by drawing air through MSA mercury sampling tubes using a battery operated personal sampling pump at a nominal flowrate of 0.2 liters per minute. This method is effective for the collection of elemental and chemically bound mercury vapor as well as particulate mercury. Immediately after sampling the silver impregnated activated charcoal tubes were sealed and shipped to the laboratory for analysis.

In the laboratory, each sample was desorbed using aqua regia at 95°C for two minutes followed by oxidation with potassium permanganate to remove interferences caused by sulfides and chlorides. The resulting solution was then analyzed by the cold vapor technique. This technique employs a hydride generator which reduces the mercury present in the sample to its elemental state and aerates it from solution. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) at 253.7 nanometers is measured as a function of mercury concentration and recorded. Samples of known concentration and blank (control) samples are analyzed in parallel with the field samples. The concentration of mercury in the samples is then calculated with any necessary corrections and reported as total elemental mercury per sample.

HYDRAZINE

A calibrated personal sampling pump was used to draw a known volume of air through a filtered glass bubbler containing 10 milliliters of collection medium. The flowrate used was approximately 1 liter per minute with a greater than 100 liter sample as a minimum volume. The collection medium used was 0.1M hydrochloric acid. After sampling was completed, the solution was transferred to a 30 ml sample vial rinsing the bubble with 0.1 M hydrochloric acid.

The solution was then made alkaline and reacted with p-dimethylaminobanzaldehyde solution to form a colored complex. The amount of complex is determined with a spectrophotometer to give a quantitative measure of hydrazine. A value was determined (in micrograms) and the airborne concentration calculated and subsequently reported in mg/m^3. Adjustments in this value were made (if necessary) by subtracting the blank value run in parallel with the analysis.

CYCLOHEXYLAMINE

A calibrated sampling pump was used to collect a known volume of air (at an approximate flowrate of 0.1 l/min.) The collection medium used was a silica gel tube (7 cm long by 4-mm I.D.) containing two sections of 20/40 mesh silica gel separated by 2-mm portion of methane foam. The absorbing section contains approximately 150 mg of silica gel, and the backup section contains approximately 75 mg.

The analyte was desorbed from the silica gel with 0.5 M sulfuric acid, and an aliquot of the desorbed sample was neutralized with 1.2 M sodium hydroxide. The sample was separated and analyzed using a gas chromatograph with a nitrogen-phosphorous detector.

Areas beneath the resultant peaks are then integrated to obtain a value of the analyte present (in micrograms) in the sample. From this value and the total air volume sampled, the concentration of cyclohexylamine may be calculated in mg/m3. Desorption efficiencies and blanks are run in parallel with the samples utilizing spiked and blank silica gel tubes, respectively. The sample values are then adjusted accordingly.

CHLORINE

Area samples taken to evaluate the concentration of chlorine gas were obtained using colorimetric indicator tubes with a sampling pump calibrated at approximately 20 cc/min. The concentration of chlorine was obtained directly from the graduated indicator tube as a length of stain indication. The color change is from white to yellow and is brought about through a reaction of chlorine in the ambient air with ortho-tolidine.

NITROGEN DIOXIDE

Integrated, long-term sampling was performed by drawing air at measured flowrates (nominal 10-20 cm^3/min) through a color change detector tube by a battery-powered, portable pump.

In the detector tube sampling system, the indication is based on the reaction of nitrogen dioxide with diphenyl benzidine which provides a color change of yellow to dark blue-grey. The length of stain shown by the detector chemical is proportional to the nitrogen dioxide concentration which must be calculated in conjunction with the air volume sampled.

CARBON MONOXIDE

Sampling for carbon monoxide (CO) was conducted by using the following two techniques.

Short-term area sampling (direct reading instantaneous) was performed either by drawing measured volumes of air through a length of stain detector tube via a hand-operated sampling pump, or by a direct-reading meter.

In the detector tube system, the CO indication is based upon the reduction of potassium palladosulfite impregnated silica gel giving a color change of yellow to brown in the presence of CO. The length of stain of the detector chemical is proportional to the CO concentration (in ppm) and must be matched to a chart corresponding to the number of pump strokes employed (1 full stroke = 100 cc) on the instruction sheet which accompanies the tubes.

The basic principle of operation of the direct reading meter involves drawing air (pre-cleansed to remove interferences) through an electrochemical sensor cell at a nominal flowrate of 700 cc/minute. The sensor cell is composed of a catalytically active sensing electrode (platinum), a counter electrode, a reference electrode and an aqueous sulfuric acid solution as the electrolyte. In the direct reading meter, the electrochemical process is carried out at a potential-controlled electrode. The current measured upon introduction of CO to the sensor cell is the result of the electro-oxidation of CO to carbon dioxide (CO_2) and is proportional to the partial pressure of CO in the sampled air.

ASBESTOS (airborne)

Samples for the determination of airborne asbestos fibers were collected by drawing air at measured flowrates through open-face cassettes containing 37-millimeter diameter cellulose ester membrane filters (Millipore, Type AA) using battery-powered, portable pumps. After collection of each sample the cassette was covered and sealed immediately for transport to the laboratory.

Each sample was analyzed subsequently for asbestos fibers using the microscopic technique currently specified by the National Institute for Occupational Safety and Health (NIOSH). Briefly, the technique consisted of the following steps: a wedgeshaped sector of each filter was cut carefully from the sample and mounted on a standard microscope slide, using a high-viscosity solution of membrane filter material in a 1:1 mixture of diethyl oxalate and dimethyl phthalate to render the filter transparent. Asbestos fibers, defined as particules having aspect ratios (apparent length to width) of three or greater, which were observable on the surface of the filter were counted using a binocular microscope equipped with 10X eyepieces and a 40X objective with phase contrast illumination. Porton reticle fields, selected at random on the sample, were examined and fibers greater than five micrometers in length were counted until either of two conditions was satisfied:

1. A minimum of 100 fibers was counted in 20 or more fields.

2. A minimum of 100 fields was examined.

Results of the microscopic analyses were used in conjunction with field sampling data (measured flowrates and durations of sampling) to calculate the concentrations of airborne asbestos fibers corresponding to each sample in units of fibers greater than five micrometers in length per cubic centimeter of air (fibers 5um per cc).

ANALYSIS OF BULK SAMPLES FOR ASBESTOS BY X-RAY DIFFRACTOMETRY

Sample material is ground in a ball mill for ten minutes. A precisely weighed portion of the ground sample (approximately 100 mg) is weighed and suspended in a solution of 0.05% Triton X-100 to obtain a suspension of approximately 100 mg sample per liter.

Fifty ml of suspension is filtered by vacuum through a 25 mm diameter Nucleport (polycarbonate membrane) filter (0.4 um port size).

The filter sample is then analyzed by X-ray diffraction employing a copper target emitting K a radiation of wave-length 1.542A. (This is a mean value calculated using the equation $K\,a = 1/3\,(K\,a_2 + K\,a_1)$ where $Ka_1 = 1.540$ and $Ka_2 = 1.544$. A scintillation detector monitors in the intensity of the diffracted energy as the samples are scanned in the range $2\,\Theta = 7.5$ to 14^{o}. (Where Θ is the angle of incidence of the radiation in the Bragg equation: $n = 2d \sin \Theta$. If diffraction peaks are detected corresponding to the primary diffraction peaks of the asbestos forms (e.g. the primary diffraction peak of chrysotile at $2\,\Theta = 12.0$ and the primary peak of amosite at $2\,\Theta = 10.5$), or if interferences are present in this region, the sample is scanned from $2\,\Theta = 23.0$ to 36.0 and any peaks of the asbestos forms. The quantity of asbestos present in each sample is determined by comparison of the heights of the appropriate diffraction peaks on the sample diffraction scans with the heights of the corresponding peaks on the diffraction scans of standards prepared in like manner.

APPENDIX B

Summary of Sampling Results

NOISE EXPOSURE DATA SHEET

Company Iowa Power and Light (DPS) Date 9/21/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 6-10 and 7-11 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
2752	*	J. L. Osterson, Fuel Handler	1543	7.95 hours	--	--	78.5	
	-	Breaker House	0746					
2753	*	J. C. Miksell, Equip. Operator	1530	8.0 hours	--	--	85.1	
	-	Equip. Op. 6-10 roving	0730					
2750	*	T. C. Bartram, Fuel Handler	1542	7.93 hours	--	--	88.3	
	-	Cat. Operator	0747					
7023	2844	J. Hupton, Equip. Operator	1418	7.03 hours	61%	69%	87.5	X
		Equip. Op. 7-11 roving	0716					
		* See minute-by-minute noise						
		exposure printout for this	employee					

NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (DPS) Date 9/22/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 6-10 & 7-11 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
7023	2844	J. Hupton, Equip. Operator	1433	7.80 hr.	94%	96%	89.8	
		Operator, 7-11 roving	0645					
7781	2841	J. C. Miksell, Equip. Operator	1432	7.77 hr.	86%	89%	89.1	
		Operator, 6-10 roving	0646					
9812	6937	W. W. Casner, Fuel Handler	1541	7.87 hr.	71%	72%	87.7	
		Forman	0749					
9414	6938	S. D. Allgeier	1540	7.35 hr.	11%	12%	74.7	
		Janitor	0819					
9298	6940	R. C. Otis, Station Control Op.	1539	7.88 hr.	60%	61%	86.5	X
		Shaker House	0746					

NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (CBS) Date 9/23/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 1, 2, & 3 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
7781	2841	J. S. Cobb, Equip. Operator Turbine Side Units 1 & 2	1346 0635	7.18 hr.	53%	59%	86.3	
7023	2844	D. L. Thomson, Equip. Operator #3 Turbine Side	1505 0654	8.18 hr.	38%	37%	82.9	
9711	1774	E. G. Brazeal Coal Handler, D-9 Cat Opr.	1437 0728	7.15 hr.	100%	112%	90.9	
9710	2163	J. A. Scott Coal Handler Foreman	1433 0730	7.05 hr.	19%	22%	78.9	
7780	2162	R. A. Carey Laborer, Units 1, 2, & 3	1419 0822	5.95 hr.	63%	85%	88.9	

NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (CBS) Date 9/24/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 1, 2, & 3 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
9710	2163	J. E. Condecon	1331	6.68 hr.	55%	66%	87.0	X
		Equip. Operator, Units 1 & 2	0650					
7023	2844	L. F. Peracy	1331	6.67 hr.	59%	71%	87.6	X
		Equip. Operator, Units 1 & 2	0651					
7780	2162	J. A. Cobb	1331	6.67 hr.	52%	62%	86.8	X
		Equip. Operator, Units 1 & 2	0651					
9711	1774	D. R. Whannell	1420	7.4 hr.	41%	44%	84.1	
		Equip. Operator, Unit 3	0656					
7781	2841	D. L. Thompson	1420	7.37 hr.	91%	99%	89.9	
		Equip. Operator, Unit 3	0658					

NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (CBS) Date 9/24/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 1, 2, & 3 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/ Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
9298	6940	R. A. Caney Laborer	1534 0755	7.65 hr.	86%	90%	89.5	
9806	4428	S. J. Alpen Laborer	1530 0755	7.58 hr.	11%	12%	74.5	X
9808	4429	J. L. Irwin Laborer	1520 0800	7.33 hr.	27%	29%	81.2	
9812	6937	J. L. Razur Coal Handler, Scrapper	1435 0920	5.25 hr.	90%	137%	92.7	
9414	6938	D. D. Feller Coal Handler, D-9 Cat.	1432 0920	5.2 hr.	91%	140%	92.9	

NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (CBS) Date 9/25/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 1, 2, & 3 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
9812	6937	D. D. Feller, Coal Handler	1423	6.97 hr.	49%	56%	85.9	
		Scrapper	0725					
9414	6939	R. P. Lee	1415	6.78 hr.	1%	1%	57.9	X
		Fly ash truck	0728					
9298	6940	S. J. Alpen	1503	7.22 hr.	88%	98%	89.9	X
		Laborer	0750					
9808	4429	R. A. Caney	1439	6.77 hr.	97%	115%	91.4	
		Laborer	0753					
9806	4428	J. L. Irwin	1440	6.77 hr.	5%	8%	71.8	
		Laborer	0754					

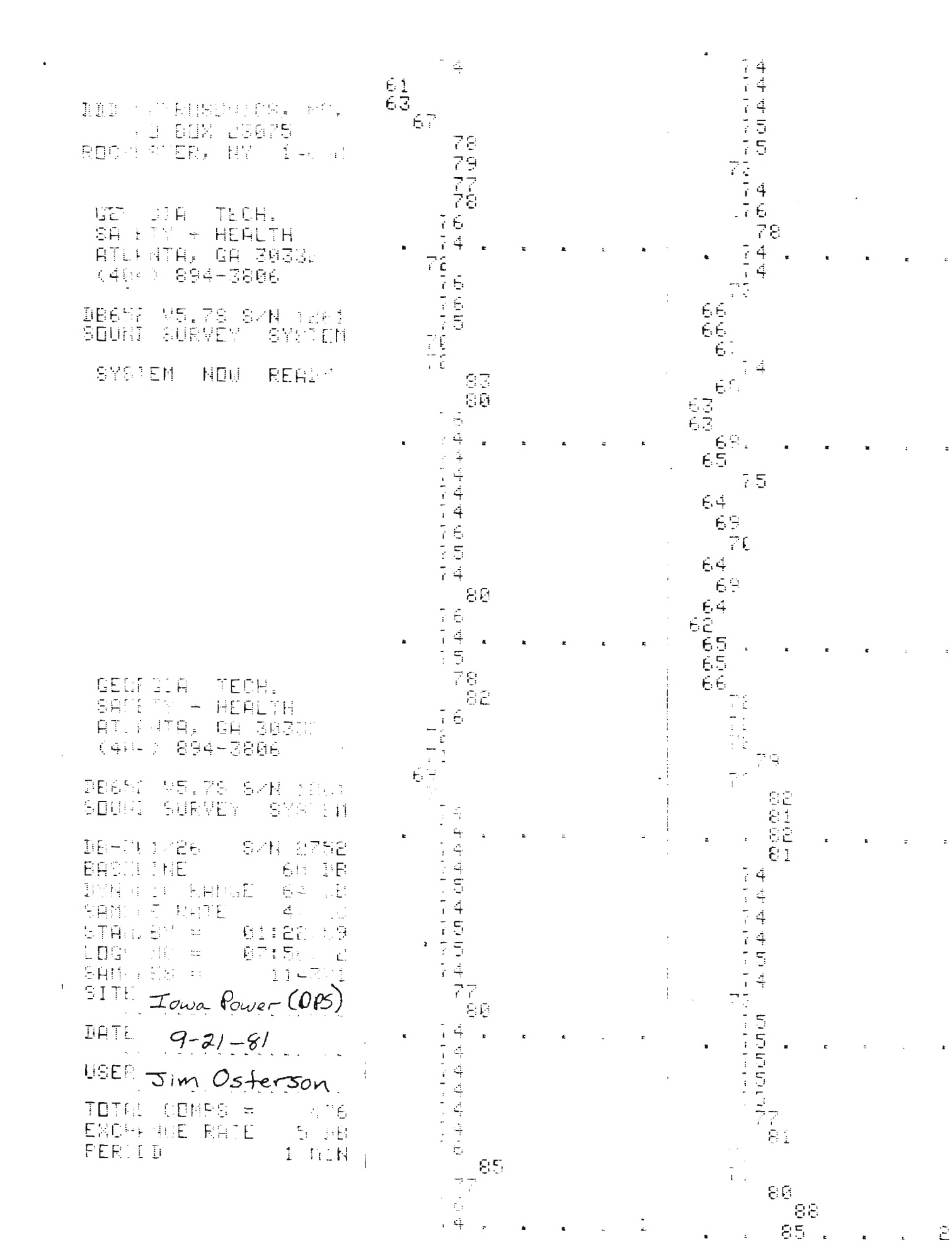
NOISE EXPOSURE DATA SHEET

Company Iowa Power & Light Co. (CBS) Date 9/25/81 Test by J. Burson/T. Shiftlett

Readout Model No. R-225 S/N 901491

Operating Conditions Units 1, 2, & 3 operating Calibrator Model No. C-114 S/N --

Unit No.	Cell No.	Employee Name / Job Description	Exposure Period: Stop/Start	Exposure Period: Total Time (hrs.)	Percent of 90 dBA: Indicated	Percent of 90 dBA: Adjusted to 8 hrs.	Equivalent 8-hour Exposure (dBA)	115 dBA Exceeded (X)
7780	2612	M. E. Harrison Mechanic, Condensate pumps under Unit #3	1448 0756	6.87 hr.	80%	93%	89.7	X
7781	2841	J. R. Marshall Mechanic, Condensate pumps under Unit #3	1449 0757	6.87 hr.	65%	76%	88.2	
7023	2844	M. J. O'Conner Mechanic, Precipitator ½ day Soot Blower ½ day	1505 0757	7.13 hr.	62%	70%	87.5	
9710	2163	D. R. Schupp Mechanic, Foreman	1500 0757	7.05 hr.	55%	62%	86.8	
9711	1774	C. Hellbusch Mechanic, Condensate pumps under Unit #3	1448 0757	6.85 hr.	71%	83%	88.8	


GEORGIA TECH,
SAFETY - HEALTH
ATLANTA, GA 30332
(404) 894-3806
DB6MT V5.7S S/N 1281
SOUND SURVEY SYSTEM
SYSTEM NOW READY
GEORGIA TECH,
SAFETY - HEALTH
ATLANTA, GA 30332
(404) 894-3806
DB6MT V5.7S S/N 1281
SOUND SURVEY SYSTEM
DB-CM 1/2S S/N 8752
BASELINE 60 DB
DYNAMIC RANGE 6S DB
SAMPLE RATE 4S
START AT = 01:22:39
LOG END = 07:5S:S2
SAMPLES = 11S711
SITE Iowa Power (OPS)
DATE 9-21-81
USER Jim Osterson
TOTAL COMPS = 476
EXCHANGE RATE 5 MIN
PERIOD 1 HOUR

				1	1	1
6	1	8	9	0	1	2
0	1	0	0	0	0	0

HOUR	LOSHA CURRENT	CUMUL
1	75.7	75.7
2	75.1	75.4
3	80.3	77.4
4	76.8	77.3
5	74.0	76.7
6	78.9	77.1
7	76.5	77.0
8	84.7	78.5

III METROSONICS, INC.

[illegible]
P.O. BOX 23075
[illegible]

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

[illegible]
SOUND SURVEY SYSTEM

[illegible]

GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

[illegible]

[illegible]
BASE LINE 80 dB
DYNAMIC RANGE 64 dB
SAMPLE RATE 4/SEC
STANDBY = 00:31:29
LOGGING = 03:04:44
SAMPLES = 1152
SITE Iowa Power (DPS)

DATE 9-21-81

USER John Miksell

TOTAL DOSE = 100
EXCHANGE RATE 5 dB
PERIOD 1 HOUR

[illegible]

5		8	9	5	
0	0	0	0	0	0
HRS					HRS

HRS

				1	1	1
6	1	8	9	0	1	2
0	0	0	0	0	0	0

HOU	LOSHA LUKRENT	COMBL
1	85.6	85.6
2	90.0	88.2
3	86.4	87.6
4	83.8	86.0
5	81.4	85.0
6	79.7	83.9
7	80.6	83.5
8	81.2	83.1

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GEORGIA TECH.
SAFETY + HEALTH
ATLANTA, GA 30332
(404) 894-3806

DBMS V5.7S S/N [illegible]
SOUND SURVEY SYSTEM

DB-IN 1/26 S/N 2750
BASELINE 60 DB
DYNAMIC RANGE 64 DB
SAMPLE RATE 4 KHZ
START = 01:24:09
LOG OFF = 07:51:[illegible]
SAMPLES = 114 25

SITE Iowa Power (DPS)

DATE 9-21-81

USER Tom Bartram

TOTAL COMPS = 475
EXCHANGE RATE 5 DB
PERIOD 1 MIN

TIME HISTORY

			1			2
6	1	8	9.0	1		2
0	5	0	0	0	0	0
HRS						HRS

				1	1	1
6	7	8	9	0	1	2
0	0	0	0	0	0	0

HOU	LOSHA CURRENT	CUMUL
1	91.9	[illegible]
2	85.7	[illegible]
3	90.4	[illegible]
4	88.9	[illegible]
5	89.8	[illegible]
6	89.4	[illegible]
7	86.8	[illegible]
8	87.0	[illegible]

III METROSONICS, INC.

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Des Moines Power Station (DPS)

Material Total Respirable Dust (TRD) &
Free Silica

Date	Sample Number	Description	Sampling Period*		Total Sample Weight (mg)	Sample Volume (Liters)	Concentration			OSHA & ACGIH** Standard 10 mg/m³ / % SiO_2+2
			Start	Stop			TRD (mg/m³)	~~SiO_2 (mg/m³)~~	SiO_2 (%)	
9/21/81	RD-1 #2509	W. W. Casner Fuel Handler Foreman	0745	1541	--	857	0.30		9.5	0.87
9/21/81	RD-2 #2553	R. C. Otis, Station Operator Dist. Floor, Bunkers 10 & 11	0746	1541	--	855	0.23		8.5	0.95
9/21/81	RD-3 #2544	J. L. Osterson, Fuel Handler Breaker House	0745	1440	--	747	0.06		11.6	0.74
9/22/81	RD-4 #2544	R. C. Otis, Station Operator Shaker House	0744	1539	--	747	0.04		16.7	0.53
9/22/81	RD-5 #2509	J. A. Taylor, Fuel Handler Dist. floor	0754	1546	--	850	0.31		8.8	0.93
9/22/81	RD-6 #2541	J. L. Osterson, Fuel Handler Breaker House	0749	1300	--	560	0.07		ND	5.0
9/22/81	RD-7 #7672	T. Plazzo, Equipment Operator Sandblasting	0818	1046	--	266	5.1		48.2	0.20

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Council Bluffs Power Station (CBS)

Material Total Respirable Dust (TRD) &
Free Silica

Date	Sample Number	Description	Sampling Period*		Total Sample Weight (mg)	Sample Volume (Liters)	Concentration			OSHA & ACGIH** Standard 10 mg/m^3 / % SiO_2+2
			Start	Stop			TRD (mg/m^3)	~~SiO_2~~ (~~mg/m^3~~)	SiO_2 (%)	
9/23/81	RD-8 #2544	D. D. Feller, Coal Handler Operating scraper	0726	1420	--	745	0.55		1.7	2.7
9/23/81	RD-10 #2553	M. G. Damgaard Coal Handler	0925	1435	--	558	0.62		2.9	2.0
9/24/81	RD-11 #2541	R. P. Lee Coal Handler Foreman	0922	1435	--	563	0.08		ND	5.0
9/24/81	RD-12 #2544	J. A. Scott Coal Handler Foreman	0919	1435	--	569	0.84		3.0	2.0
9/24/81	RD-13 #2509	D. D. Feller, Coal Handler D-9 Cat	0920	1435	--	567	0.28		ND	5.0
9/24/81	RD-14 #7727	R. E. Wilson, Coal Handler Breaker House	1509	2210	--	758	0.01		ND	5.0

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power and Light Co.
Council Bluffs Power Station (CBS)

Material Total Respirable Dust (TRD) &
Free Silica

Date	Sample Number	Description	Sampling Period*		Total Sample Weight (mg)	Sample Volume (Liters)	Concentration			OSHA & ACGIH** Standard 10 mg/m^3 / % SiO_2+2
			Start	Stop			TRD (mg/m^3)	~~SiO_2 (mg/m^3)~~	SiO_2 (%)	
9/24/81	RD-15 #-7716	H. Peterson, Coal Handler Tripper Floor 1 & 2	1604	2210	-	659	0.09		ND	
9/24/81	RD-16 #2509	J. A. Scott, Coal Handler Foreman	0722	1424	-	760	0.39		ND	
9/24/81	RD-17 #2544	S. P. Duff Coal Handler	0723	1423	-	756	0.15		12.7	0.68

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Des Moines Power Station

Materials Total Weight (TW), Iron (Fe),
Manganese (Mn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TW mg/m^3	Fe mg/m^3	Mn mg/m^3
9/21/81	TD-1 #7169	M. P. Kouri, Plant Attendant	1010	1405	470	235	0.48	0.004	<0.001
9/21/81	TD-2 #7644	S. D. Allgeier, Janitor	0753	1540	840	420	0.07	0.011	<0.001
9/22/81	TD-3 #7644	J. E. Cline, Plant Attendant	0635	1420	930	465	0.11	<0.001	<0.001
9/22/81	TD-4 #7169	S. K. Williams, Plant Attendant	0738	1419	802	401	0.02	<0.001	<0.001
9/22/81	TD-5 #7702	T. C. Bartram, Cat Operator Fuel Handler	0747	1546	958	479	0.07	0.010	<0.001
9/22/81	TD-6 #7709	E. H. Breton, Cutting & Welding Tank Mechanic	0956	1520	648	324	0.62	0.001	0.006

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Council Bluffs Power Station (CBS)

Materials Total Weight (TW), Iron (Fe),
Manganese (Mn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TW mg/m^3	Fe mg/m^3	Mn mg/m^3
9/23/81	TD-7 #7702	T. L. Bressman Units 1 & 2 Equipment Operator	0633	1346	866	433	2.91	0.071	0.001
9/23/81	TD-8 #7719	L. F. Pearcy Units 1 & 2 Equipment Operator	0635	1346	862	431	2.87	0.005	<0.001
9/23/81	TD-9 #7710	J. L. Razur Fly Ash Truck Coal Handler	0725	1432	854	427	4.79	0.132	0.002
9/23/81	TD-10 #7689	R. E. Boseck Unit 3 Equipment Operator	0639	1505	802	401	0.08	0.006	<0.001
9/23/81	TD-11 #2541	J. L. Irwin, Laborer	0818	1419	962	481	0.07	0.005	<0.001
9/23/81	TD-12 #2509	D. B. Campbell, Laborer	0820	1255	550	275	0.05	0.008	<0.001
9/24/81	TD-13 #7644	R. A. Carey, Laborer	0754	1533	918	459	9.11	0.55	0.001

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Council Bluffs Power Station (CBS)

Materials Total Weight (TW), Arsenic (As), Zinc (Zn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TW mg/m^3	As mg/m^3	Zn mg/m^3
9/23/81	TD-7 #7702	T. L. Bressman Units 1 & 2 Equipment Operator	0633	1346	866	433	2.91	0.001	0.004
9/23/81	TD-8 #7719	L. F. Pearcy Units 1 & 2 Equipment Operator	0635	1346	862	431	2.87	<0.001	0.002
9/23/81	TD-9 #7710	J. L. Razur Fly Ash Truck Coal Handler	0725	1432	854	427	4.79	<0.005	0.003
9/23/81	TD-10 #7689	R. E. Boseck Unit 3 Equipment Operator	0639	1505	802	401	0.08	<0.001	0.002
9/23/81	TD-11 #2541	J. L. Irwin Laborer	0818	1419	962	481	0.07	<0.001	0.004
9/23/81	TD-12 #2509	D. B. Campbell Laborer	0820	1255	550	275	0.05	0.001	0.003
9/24/81	TD-13 #7644	R. A. Carey Laborer	0754	1533	918	459	9.11	0.001	0.010

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Council Bluffs Power Station (CBS)

Materials Total Weight (TW), Iron (Fe), Manganese (Mn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TW mg/m^3	Fe mg/m^3	Mn mg/m^3
9/24/81	TD-14 #7709	S. J. Alpen, Laborer	0757	1522	890	445	3.56	0.009	<0.001
9/24/81	TD-15 #7169	D. B. Campbell, Laborer	0800	1530	900	450	0.72	0.025	<0.001
9/24/81	TD-16 #7716	R. L. Reeh Welding Mild Steel Mechanic	1345	1410	50	25	62.8	15.62	2.67
9/25/81	TD-17 #7169	E. G. Brazeal Fly Ash Truck Coal Handler	0753	1415	816	408	0.46	0.016	<0.001
9/25/81	TD-18 #7718	R. A. Carey, Laborer	0753	1437	808	404	0.21	0.005	<0.001
9/25/81	TD-19 #7710	J. L. Irwin, Laborer	0753	1437	808	404	1.14	0.005	<0.001
9/25/81	TD-20 #7702	R. L. Reeh Welding Mild Steel Mechanic	0954	1010	32	16	109.4	28.64	3.95

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Council Bluffs Power Station (CBS)

Materials Total Weight (TW), Arsenic (As), Zinc (Zn)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			TW mg/m^3	As mg/m^3	Zn mg/m^3
9/24/81	TD-14 #7709	S. J. Alpen, Laborer	0757	1522	890	445	3.56	<0.001	0.003
9/24/81	TD-15 #7169	D. B. Campbell, Laborer	0800	1530	900	450	0.72	0.001	0.003
9/24/81	TD-16 #7716	R. L. Reeh Welding Mild Steel Mechanic	1345	1410	50	25	62.8	<0.002	23.77
9/25/81	TD-17 #7169	E. G. Brazeal Fly Ash Truck Coal Handler	0753	1415	816	408	0.46	0.001	0.003
9/25/81	TD-18 #7718	R. A. Carey, Laborer	0753	1437	808	404	0.21	<0.001	0.005
9/25/81	TD-19 #7710	J. L. Irwin, Laborer	0753	1437	808	404	1.14	<0.001	<0.001
9/25/81	TD-20 #7702	R. L. Reeh Welding Mild Steel Mechanic	0954	1010	32	16	109.4	<0.03	11.82

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.

DPS & CBS

Materials Mercury (Hg)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			Hg ug/m^3		Power Station
9/21/81	Hg-1 #1-3088	C. Welcher, Filling Manometer Mechanic	1008	1519	14.9	153	0.013		DPS
9/23/81	Hg-2 #1-3088	C. E. Wagner, Filling Manometer Mechanic	0826	0858	3.1	32	ND		CPS
9/23/81	Hg-3 #1-3063	J. H. Beno, Filling Manometer Mechanic	0827	0858	3.0	31	ND		CPS

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Des Moines Power Station (DPS)

Materials Cyclohexylamine (CY)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			CY mg/m^3		
9/21/81	CY-1 #7710	Area Sample - Chemical Storage Room over Cyclohexylamine Drum	0922	1309	227	227	0.05		

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
DPS & CBS

Materials Hydrazine (Hz)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			Hz mg/m^3		Power Station
9/21/81	Hz-1 #7727	Area Sample - Chemical Storage Room over Hydrazine Drum	0922	1309	227	227	<0.01		DPS
9/23/81	Hz-2 #7710	Area Sample - Sampler on Unit #1 Hydrazine Pump	0718	1318	360	360	<0.01		CPS
9/23/81	Hz-3 #7727	Area Sample - Sampler on Unit #2 Hydrazine Pump	0718	1318	360	360	<0.01		CPS
9/23/81	Hz-4 #7713	Area Sample - Sampler on Unit #3 Hydrazine Pump	0728	1320	352	352	<0.01		CPS

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.
Des Moines Power Station (DPS)

Materials Chlorine (Cl_2)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			Cl_2 ul	Cl_2 ppm	
9/21/81	CL-1 #1-3230	Area Sampler Center of Chlorine House	0825	1405	6.8	340	4.5	0.66	
9/22/81	CL-2 #1-3117	Area Sampler Center of Chlorine House	0700	1345	8.1	405	ND	--	
		Window Open							

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co.

DPS & CBS

Materials Nitrogen Dioxide (NO_2)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			NO_2 ul	NO_2 ppm	Power Station
9/21/81	NO-1 #1-3357	Area Sampler at 111C Burner	0722	1449	8.49	447	ND	-	DPS
9/22/81	NO-2 #1-3230	Area Sampler Unit #10 Boiler 102C Burner	0840	1335	5.9	295	ND	-	DPS
9/23/81	NO-3 #1-3357	Area Sampler Boiler #1 Burners 7 & 8	0805	1351	6.9	346	ND	-	CPS

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Co. **Materials** Carbon Monoxide (CO)

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration		
			Start	Stop			CO ul	CO ppm	Power Station
9/21/81	CO-1 #1-3117	Area Sample at 111C Burner	0722	1449	8.94	447	280	31	DPS
9/22/81	CO-2 #1-3357	Area Sampler, Unit #10 Boiler 102C Burner	0840	1335	5.9	295	Trace	-	DPS
9/23/81	CO-3 #1-3230	Area Sampler, Boiler #1 Burners 7 & 8	0805	1351	6.9	346	Trace	-	CPS

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power & Light Company

Des Moines Power Station

Materials Asbestos

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			fibers/ 100 fields	fibers/ml
9/21/81	AB-1 #7672	D. E. Sweitzer Asbestos clean-up - old side, 6th level	0759	0845	92	46	0	<0.02
9/21/81	AB-2 #7709	T. Plazzo Asbestos clean-up	0759	0845	92	46	0	<0.02
9/21/81	AB-3 #7689	Asbestos Area Sample Operating floor, Unit 10, near coal feeders	0820	1447	774	387	0	<0.01
9/21/81	AB-4 #7709	T. Plazzo Asbestos clean-up	0945	1036	102	51	0	<0.02
9/21/81	AB-5 #7672	D. E. Sweitzer Asbestos clean-up	0937	1036	118	59	0	<0.01
9/22/81	AB-6 #7689	Asbestos Area Sample Operating floor, Unit 11, feed water regulator	0830	1340	620	310	0	<0.01

INDUSTRIAL HYGIENE SAMPLING SUMMARY

Plant Iowa Power and Light Company

Council Bluffs Power Station

Materials Asbestos

Date	Sample Number	Description	Sampling Period		Sample Volume (Liters)	Sample Time (Min.)	Concentration	
			Start	Stop			fibers/ 100 fields	fibers/ml
9/23/81	AB-7 #2553	Asbestos Area Sample Unit 2, Level 4, Water Treatment	0809	1448	738	369	0	<0.01
9/23/81	AB-8 #7169	R. A. Carey, Laborer Transferring asbestos for disposal	1253	1419	172	86	0	<0.01
9/23/81	AB-9 #7644	D. B. Campbell Transferring asbestos for disposal	1253	1419	172	86	0	<0.01
9/24/81	AB-10 #7689	R. L. Reeh Removing insulation from pipe	1325	1337	24	12	0	<0.08

APPENDIX C

Toxicological Information

Noise
Coal Dust
Siliceous Dust
Nuisance Dust
Arsenic And Its Inorganic Compounds
Iron And Its Compounds
Manganese And Its Compounds
Zinc And Its Compounds
Hydrazine And Its Derivatives
Cyclohexylamine
Chlorine
Nitrogen Oxides
Carbon Monoxide
Asbestos

NOISE

The major potential health hazard associated with exposure to noise lies in the possibility of producing permanent hearing loss. Factors which play a role in deciding how much permanent hearing loss will be sustained after exposure to high noise levels include the level and frequency of the noise, the duration of exposure per day, the number of years of repeated daily exposure, and individual susceptibility (age, genetic make-up, diet, and use of autotoxic drugs are just some of the variables which determine individual susceptibility).

The other adverse effects suspected as being caused by high noise levels include physiological disturbances (high blood pressure, aural pain, nausea and impaired muscular control when exposure is severe), and an increase in the accident frequency rate resulting from interference with speech communication and the disrupting of concentration. Also, some temporary hearing loss results from daily exposure to high noise levels, reportedly because the hair cells in the inner ear become fatigued and can no longer respond as well.

The standard as set by the Occupational Safety and Health Administration (OSHA) is based on daily time-weighted average exposure limits (over an eight-hour period) which, it is thought, will protect most workers from serious hearing loss.

The elements of the OSHA standard are:

1. The acceptable level of continuous noise (amplitude peaks less than one second apart) for exposures of eight hours duration is 90 decibels (dB) as measured on the A-weighted integrating network of a Type II sound level meter set on slow response, which approximates the response of the normal human ear to sound.

2. For each additional 5 dBA above 90, the permissible exposure time is reduced by half (see Table 1 below).

TABLE 1

PERMISSIBLE NOISE EXPOSURES

Sound Level (dBA)	Hours/Day Duration
90	8
92	6
95	4
97	3
100	2
102	1½
105	1
110	½
115	¼ or less

3. No exposure to continuous noise levels in excess of 115 dBA is acceptable, regardless of duration.

4. Exposure to impulsive or impact noise (amplitude peaks greater than one second apart) in excess of 140 dB peak sound pressure level is unacceptable.

5. When workers are being overexposed on the basis of the criteria in Table 1, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

6. In all cases where the noise levels exceed an equivalent noise level of 85 dBA, including noise levels from 80 to 130 dBA, a continuing effective hearing conservation program shall be administered. The allowable duration of exposure is determined by the formula:

$$\text{Allowable time (Hours)} = \frac{32}{2^{(L-80)/5}}$$

where L is the sound level measured on the A weighted scale (dBA).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, as it is in most jobs in industrial settings, the combined effect shall be considered, rather than the individual effect of each. This combined effect, or total exposure, is determined by the following exposure formula.

$$\text{Exposure} = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Where C_n is the actual time spent at sound level, n (in dBA), and T_n is the allowable time spent at sound level, n.

OSHA has defined an effective hearing conservation program, but parts of the definition have been stayed. The portions which have not been stayed are summarized below:

1. Baseline audiometric testing must be completed by August 22, 1982, and repeated annually thereafter. All audiograms must be kept for the duration of employment.

2. Audiometric tests must be given by a trained individual and the audiometer must meet the ANSI S36-1969 criteria. Audiometer calibrations must be done as stated in the OSHA standard.

3. Audiograms showing a significant threshold shift must be reviewed by an audiologist, otolaryngologist, or qualified physician.

4. Employees must be notified of audiogram results within 21 days of receipt of the results. Hearing protection must be worn by employees having a significant threshold shift when working in areas where noise levels exceed 85 dBA.

5. Employees exposed to an equivalent noise level of 85 dBA or greater must have annual training which includes discussions of the effects of noise on man, the use of hearing protection, and audiometric testing.

6. When employees are exposed to greater than 90 dBA a written plan to reduce noise exposures to less than an equivalent noise level of 90 dBA must be formed. The plan may include both engineering and administrative controls.

COAL DUST

Coal is a native, black or brownish, brittle or soft substance consisting chiefly of carbon, but also of hydrogen, nitrogen, oxygen and other elements (Si,P,As,Fe, etc.).

A commonly used term for chest disease resulting from inhalation of coal dust is coal workers' pneumoconiosis. Another frequently used term is anthrosilicosis, an appropriate description, since all coals contain not only carbon, but varying amounts of silica.

In chronic respiratory disease of coal workers, the onset is gradual, often forcing the patient to seek medical advice for the first time only after a bacterial infection or heavy exposure to dust in a mine accident. Cough, wheezing, severe dyspnea, and sputum production varies with infection and smoking habits. The sputum is usually black, and in advanced disease large amounts of thick material referred to as melanosis are produced indicating cavities caused by aseptic necrosis. Tuberculosis and bacterial pneumonia, although more manageable with modern chemotherapy, are serious complications. Pulmonary arterial circulation involvement and right heart failure are secondary to emphysema and hypoxia leading to increasing disability and death.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of 2.4 mg/m^3 for "respirable" coal dust containing less than five percent quartz, and established the following formula as an eight-hour, TWA concentration limit for respirable coal dust containing more than five percent quartz:

$$TLV = \frac{10\ mg/m^3}{\%\ SiO_2 + 2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted an eight-hour, TWA threshold limit value of 2 mg/m^3 for respirable coal dust containing less than five percent quartz. If the coal dust contains more than five percent quartz, ACGIH also recommends the respirable mass formula established by OSHA. The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m^3 of free silica in respirable dusts.

SILICEOUS DUSTS

Free silica (SiO_2, uncombined and independent of other elements) has three crystalline forms: quartz, tridymite, and cristobalite. All three forms have similar physiologic action. The potential health hazard associated with exposure to crystalline silica is that of inhalation of the dust. Inhalation of extreme concentrations of submicron particles can lead to diffuse, fulminating lung fibrosis within a few months. However, development of the more common chronic type of silicosis usually takes many years. The effects of repeated is characterized by an initial generalized linear increase in lung density progressing to small nodules scattered throughout the lung tissue. If exposure continues, these nodules increase in size to the point where thy interfere with respiration. Although silicosis rarely causes death, common complications include tuberculosis, chronic bronchitis and bacterial infections.

The Occupational Safety and Health Administration (OSHA) has established the following formula as an eight-hour, time-weighted average (TWA) concentration limit, based on the quartz content of total dust:

$$TLV = \frac{30\ mg/m^3}{\%\ SiO_2 + 2}$$

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted a TWA threshold limit value (TLV) formula based on the free crystalline quartz content for total dust:

$$TLV = \frac{30\ mg/m^3}{\%\ SiO_2 + 3}$$

OSHA and ACGIH both have established a formula applicable to calculate acceptable air concentrations of the respirable fraction of total dust:

$$TLV = \frac{10\ mg/m^3}{\%\ SiO_2 + 2}$$

If the free crystalline silica content is composed primarily of tridymite and/or cristobalite, one-half the value calculated from the formula for quartz must be used.

The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of 0.05 mg/m3 of free silica in respirable dust.

NUISANCE DUST

In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amounts. However, the lung-tissue reaction caused by inhalation of nuisance dusts have the following characteristics:

(1) The architecture of the air spaces remains intact.

(2) Collagen (scar tissue) is not formed to a significant extent.

(3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by rigorous skin cleansing procedures necessary for their removal. They do not appear to have a predisposing effect on tuberculosis or other infection and do not cause impaired lung function.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established time-weighed average (TWA) threshold limit values of 30 mppcf (millions of particles per cubic foot of air), based on impinger samples counted by light-field techniques or 10 mg/m3 of total dust containing less than 1% quartz, or 5 mg/m3 respirable dust. The Occupational Safety and Health Administration (OSHA) has established TWA standards of 50 mppcf or 15 mg/m3 for total dust containing less than 1% quartz, or 15 mppcf or 5 mg/m3 for respirable dust.

Quite often an industrial hygienist will use a gravimetric analysis for total dust when sampling for dusts with unknown toxicity. While the results may be compared to the nuisance dust standard for a base line reading, the dusts of unknown toxicity should in no way be considered nuisance dusts because the potential for harm has not been established.

ARSENIC AND ITS INORGANIC COMPOUNDS

Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect, but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratosis, especially of the palms and soles. Arsenic has been cited as a cause of skin cancer, but the incidence is low.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: The worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, a catarrhal state of the mucous membranes of the noise, larynx, and respiratory passage. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Evidence is now available incriminating arsenic compounds as a cause of lung cancer as well as skin cancer.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of 0.01 mg/m3 as a standard for occupational exposure to inorganic arsenic (as As). The American Conference of Governmental Industrial Hygienists (ACHIH) currently lists in "Notice of Intended Changes" an eight-hour, TWA threshold limit value (TLV) of 0.2 mg/m3 for soluble arsenic (as As) and lists arsenic trioxide production in the category entitled "human carcinogens" with a TLV of 0.05 mg/m3 of As_2O_3 (as As). The National Institute for Occupational Safety and Health (NIOSH) recommends a ceiling concentration limit of 0.002 mg/m3 of inorganic arsenic (as As) for a period up to 15 minutes.

IRON AND ITS COMPOUNDS

Iron (Fe) is a malleable, silver-grey metal. Ferric oxide is a dense, dark red powder or lumps.

The inhalation of iron oxide fumes or dust may cause a benign pneumoconiosis (siderosis). It is probable that the inhalation of pure iron oxide does not cause fibrotic pulmonary changes, whereas the inhalation of iron oxide plus certain other substances may cause injury.

On the basis of epidemiological evidence, exposure to hematite dust increases the risk of lung cancer for workers working underground, but not for surface workers. It may be, however, that hematite dust becomes carcinogenic only in combination with radioactive material, ferric oxide, or silica. There is no evidence that hematite dust or ferric oxide causes cancer in any part of the body other than the lungs.

Iron compounds derive their dangerous properties from the radical with which the iron is associated. Iron pentacarbonyl is one of the more dangerous metal carbonyls. It is highly flammable and toxic. Symptoms of overexposure closely resemble those caused by nickel carbonyl ($Ni(CO)_4$) and consist of giddiness and headache, occasionally accompanied by fever, cyanosis and cough due to pulmonary edema. Death may occur within 4 to 11 days due to pneumonia, liver damage, vascular injury and central nervous system degeneration.

Soluble iron salts, especially ferric chloride and ferric sulfate, are cutaneous irritants and their aerosols are irritating to the respiratory tract. Iron compounds as a class are not associated with any particular industrial risk.

The Occupational Safety and Health Administration (OSHA) has established an eight-hour, time-weighted average (TWA) concentration limit of ten mg/m3 as a standard for occupational exposure to iron oxide fume. There are no OSHA standards for other iron compounds. The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted eight-hour, TWA threshold limit values and lists as "tentative" short-term (up to 15 minutes) exposure limits (STEL) as follows:

Compound	TWA-TLV	STEL (Tentative)
Iron Oxide fume	5 mg/m3	10 mg/m3
Iron pentacarbony	0.01 ppm (0.08 mg/m3)	--
Iron salts, soluble (as Fe)	1 mg/m^3	2 mg/m^3

MANGANESE AND ITS COMPOUNDS

Manganese (Mn) is a reddish-grey or silvery, soft metal. Manganese and its compounds can enter the body via inhalation of fume or dust and percutaneous absorption of liquids.

The early phase of chronic manganese poisoning is most difficult to recognize, but it is also most important to recognize since early removal from the exposure may arrest the course of the disease. The onset is insidious, with apathy, anorexia, and asthenia. Headache, hypersomnia, spasms, weakness of the legs, arthralgias, and irritability are frequently noted. Manganese psychosis follows with certain definitive features: unaccountable laughter, euphoria, impulsive acts, absentmindedness, mental confusion, aggressiveness, and hallucinations. These symptoms usually disappear with the onset of true neurological disturbances, or may resolve completely with removal from manganese exposure.

Progression of the disease presents a range of neurological manifestations that can vary widely among individuals affected. Speech disturbances are common: monotonous tone, inability to speak above a whisper, difficult articulation, incoherence, even complete muteness. The face may take on masklike quality, and handwriting may be affected by micrographia. Disturbances in gait and balance occur, and frequently propulsion, retropropulsion, and lateropropulsion are affected, with no movement for protection when falling. Tremors are frequent, particularly of the tongue, arms and legs. These will increase with intentional movements and are more frequent at night. Absolute detachment, broken by sporadic or spasmodic laughter, ensues, and as in extraphramidal affections, there may be excessive salivation and excessive sweating. At this point the disease is indistinguishable from classical Parkinson's disease.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established a ceiling concentration limit of five mg/m3 (as Mn) for occupational exposure to manganese and its compounds. Currently, ACGIH adopted an eight-hour, time-weighted average (TWA) threshold limit value (TLV's) of 0.1 mg/m3 (as Mn) and 1.0 mg/m3 for manganese cyclopentadienyl tricarbonyl and manganese tetroxide, respectively. ACGIH lists as "tentative" a short-term exposure limit (up to 15 minutes) of 0.3 mg/m3 for manganese cyclopentadienyl tricarbonyl. The values for this latter substance carry "skin" notation, warning of the potential for percutaneous absorption; these specific concentration limits are based on the presumption that there is no concurrent exposure via skin and oral ingestion routes.

ZINC AND ITS COMPOUNDS

Zinc (Zn) is a soft, silvery-white metal with a blue tinge.

The inhalation of freshly formed zinc fumes from the volatilization of zinc causes metal fume fever. A number of zinc salts may enter the body by inhalation, through the skin or by ingestion and produce intoxication. Zinc chloride has been found to cause skin ulcers, and a number of zinc compounds present fire and explosion hazards.

Symptoms of this metal-fume fever include shivering attacks, irregular fever, profuse sweating, nausea, thirst, headache, pains in the limbs and a feeling of exhaustion. Attacks are of short duration (most cases are on the way to complete recovery within 24 hours of onset of symptoms) and tolerance seems to be acquired.

The Occupational Safety and Health Administration (OSHA) has established eight-hour, time-weighted average (TWA) concentration limits of one mg/m3 of zinc chloride fume and five mg/m3 of zinc oxide fume. The American Conference of Governmental Industrial Hygienists (ACGIH) has established eight-hour, TWA threshold limit values (TLV's) of one mg/m3 of zinc chloride fume, 0.05 mg/m3 of zinc chromate (as Cr), five mg/m3 of zinc oxide fume, and ten mg/m3 of zinc stearate. ACGIH currently lists as "tentative" short-term (up to 15 minutes) exposure limits of two mg/m3 of zinc chloride fume, ten mg/m3 of zinc oxide fume, and 20 mg/m3 of zinc stearate. The National Institute for Occupational Safety and Health (NIOSH) has recommended a TWA concentration limit of five mg/m3 of zinc oxide fume for up to a ten-hour workday, 40-hour workweek, with a ceiling concentration limit of 15 mg/m3 for 15 minutes.

HYDRAZINE AND ITS DERIVATIVES

Hydrazine (NH_2-NH_2) is a colorless, oily liquid with an ammoniacal odor. Phenylhydrazine (C_6H_5NH-NH_2) is an oily colorless, liquid or a crystalline solid. 1,1-Dimethylhydrazine ($(CH_3)_2$-N-NH_2) is a hydroscopic mobile liquid. The potential for worker exposure to the hydrazines is primarily through two routes of exposure, inhalation and contact with skin or eyes.

Hydrazine and its derivatives are believed to pose a carcinogenic risk to humans since a wide variety of studies have shown that exposed rodents have developed an elevated incidence of lung tumors. Liver damage is the most serious effect, other than cancer, of hydrazine toxicity.

All three compounds have similar toxic local effects due to their irritant properties. The vapor is highly irritating to the eyes, upper respiratory tract, and skin, and causes delayed eye irritation. Severe exposure may produce temporary blindness. The liquid is corrosive, producing penetrating burns and severe dermatitis. Permanent corneal lesions may occur if the liquid is splashed in the eyes. A sensitization dermatitis may be produced.

Currently accepted exposure limits established or recommended by the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH) are as follows:

Chemical	Unit	OSHA	ACGIH		NIOSH
		TWA*	TWA*	STEL**	CEILING***
Hydrazine	ppm	1.0	0.1		0.03
Methylhydrazine	ppm				0.04
1,1-Dimethyl-hydrazine	ppm	0.5	0.5	1	0.06
Phenylhydrazine	ppm	5.0	5.0	10	0.14

*TWA - The time-weighted average for an eight-hour work shift in a 40-hour work week.

**STEL - (Short-term exposure limit) - The maximal concentration to which workers can be exposed for a period up to 15 minutes.

***CEILING - The maximum concentration which cannot be exceeded in any two-hour period.

All the exposure limits carry the "skin" notation, warning of the potential for percutaneous absorption; these specific concentration limits are based on the presumption that there is no concurrent exposure via the skin and oral ingestion routes.

CYCLOHEXYLAMINE

Cyclohexylamine ($C_6H_{11}NH_2$) is a colorless liquid of a strong base, with unpleasant odor. It can enter the human body via inhalation of vapor and percutaneous absorption of liquid.

It presents severe caustic actions on skin and mucous membranes. It also causes systemic effects in humans including nausea and vomiting, anxiety, restlessness, and drowsiness. Cyclohexylamine is regarded as having moderate sensitizing potential and being a weak methemoglobin-forming substance.

Some recent reports of animal experiments have indicated that cyclohexylamine might have potential carcinogenic, mutagenic or teratogenic activity. An adverse effect of oral cyclohexylamine sulfate on fertility in male rats was detected.

No chronic experimental toxicity studies on cyclohexylamine have been reported. Exposure to 4-10 ppm caused no symptoms of any kind in workmen under acute conditions.

In view of the pronounced toxic and irritant effects of cyclohexylamine and the possibility that continued absorption might lead to carcinogenic, mutagenic or teratological effects, the American Conference of Governmental Industrial Hygienists (ACGIH) has adopted an eight-hour, time-weighted average (TWA) threshold limit value (TLV) of ten parts of cyclohexylamine per million parts of air by volume. The TLV carries the "skin" notation, warning of the potential for percutaneous absorption; the TLV is based on the presumption that there is no concurrent exposure via the skin absorption and oral ingestion routes.

CHLORINE

Area samples taken to evaluate the concentration of chlorine gas were obtained using colorimetric indicator tubes with a sampling pump calibrated at approximately 20 cc/min. The concentration of chlorine was obtained directly from the graduated indicator tube as a length of stain indication. The color change is from white to yellow and is brought about through a reaction of chlorine in the ambient air with ortho-tolidine.

NITROGEN OXIDES
(NO_x)

"Nitrogen oxides" here refers to the mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). Since nitrogen dioxide in the working environment results, at least in part, from oxidation of nitric oxide, occupational exposures are usually to mixtures of these gases rather than to either gas alone. Nitric oxide is a colorless gas which reacts with oxygen to form nitrogen dioxide at ordinary temperatures. Nitrogen dioxide is a reddish-brown gas with a characteristic odor, or (below 21.1^{o}C) a yellow liquid.

Exposure to high concentrations of nitrogen oxides may result in severe pulmonary irritation and methemoglobinemia. The former is believed to be caused by the nitrogen dioxide portion, while the latter is mainly caused by nitric oxide. Typically, acute exposure may produce immediate malaise, cyanosis, cough, dyspnea, chills, fever, headache, nausea, and vomiting. Collapse and death may occur if exposure is sufficiently high. When lower concentrations are encountered, there may be only mild signs of bronchial irritation, followed by a five to twelve hour symptom-free period. Many fatalities occur because of the suddenness and severity of the effects and the characteristic delay in onset. If the acute episode is survived, "bronchiolitis fibrosa obliterans" (severe and increasing dyspnea with fever and cyanosis) may develop usually within a few days but may be latent for as long as six weeks.

Chronic exposure may result in pulmonary dysfunction. The most common complaint is of dyspnea upon exertion. Nitrogen dioxide is about four or five times as toxic as nitric oxide.

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) both have established an eight-hour, time-weighted average (TWA) concentration limit of 25 ppm as a standard for occupational exposures to nitric oxide and a ceiling concentration limit of five ppm, not to be exceeded at any time, for nitrogen dioxide. This ceiling limit for nitrogen dioxide was adopted on the basis of prevention of immediate injury or adverse physiologic effects from prolonged daily exposures. The National Institute for Occupational Safety and Health (NIOSH) has recommended a 40-hour work week, TWA concentration limit of 25 ppm for nitric oxide and a ceiling concentration limit (up to 15 minutes) of one ppm for nitrogen dioxide.

CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless gas generally produced by incomplete combustion of organic or carbonaceous materials. It is a serious hazard in many processes in the chemical, iron and steel, pottery, automobile, and mining industries.

Of all the gases that have poisonous effects upon man and animals, carbon monoxide is the most widely encountered. It exerts its effects by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissues. Although this resultant oxygen deficiency is a reversible chemical asphyxia, nevertheless, damage done by severe asphyxia from any cause may not be reversible.

The acute effects of carbon monoxide exposures are dependent on the percentage saturation of hemoglobin with carbon monoxide, which in turn is dependent on the duration of exposure, concentration of carbon monoxide, the ambient temperature, and the health status and metabolic efficiency of the worker. The approximate relationship is shown in the following table.

Atmospheric Carbon monoxide concentration (ppm)	Half-time for accumulation (min)	Carboxy-hemoglobin concentration at equilibrium %	Principal Symptoms
50	150	7	Slight headache
100	120	12	Moderate headache and dizziness
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting collapse possible
1,000	60	60	Coma
10,000	5	95	Death

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established a permissible exposure limit (PEL) for an eight-hour, time-weighted average, (TWA) exposure of 50 ppm to maintain carboxyhemoglobin levels below 10%. The National Institute for Occupational Safety and Health recommends a time-weighted average exposure of 35 ppm for an eight-hour workday, with a ceiling concentration of 200 ppm. ACGIH currently lists as "tentative value" a short-term exposure limit (up to 15 minutes) of 400 ppm.

ASBESTOS

Asbestos is a generic term referring to various fibrous mineral silicates, including chrysotile (hydrated magnesium silicate), amosite (iron-magnesium silicate), crocidolite (sodium-iron silicate), tremolite (calcium-magnesium silicate), anthophyllite (another iron-magnesium silicate), and actinolite (calcium-magnesium-iron silicate).

The potential health hazard associated with exposure to asbestos results from inhalation of airborne fibers; small asbestos fibers can pass readily through the upper respiratory tract and be deposited in the terminal bronchioles of the lung. There they can produce a local irritation which the body attempts to overcome by initiating a tissue response resulting in the encapsulation of the fibers and consequent formation of "asbestos bodies". Asbestos fibers are the causative agents in cases of asbestosis, a progressive disease characterized by diffuse interstitial fibrosis and, at times, pleural changes of fibrosis and calcification. It is often evident by such clinical signs as rales and dyspnea. In its severe form, asbestosis can contribute to, and result in, death due to the inability of the body to obtain oxygen or the heart to pump blood through the scarred lungs.

Exposure to airborne asbestos fiber also has been associated with bronchogenic carcinoma (a malignancy of the interior of the lung), mesothelioma (a diffuse malignancy of the lining of the chest or abdomen), and cancer of the stomach, colon, and rectum. Cigarette smoking can enhance the incidence of bronchogenic carcinoma from this substance.

In order to protect workers from such occupational hazards, the Occupational Safety and Health Administration (OSHA) has established a limit of two fibers (longer than five micrometers) per cubic centimeter of air as an eight-hour, time weighted average (TWA) concentration limit. This OSHA standard also specifies a ceiling (peak) exposure limit of ten fibers per cubic centimeter of air. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value of five fibers (longer than five micrometers) per cubic centimeter of air. The National Institute of Occupational Safety and Health (NIOSH) has recommended a daily TWA exposure limit of 0.1 fiber per cubic centimeter of air, with a peak concentration limit of 0.5 fibers per cubic centimeter bases on a 15 minute sample period.

APPENDIX D

Summary Of Noise Regulations

Occupational Noise Exposure

- - Action Level Equaled or Exceeded

1. Institute a hearing conservation program for all affected workers.
2. Conduct baseline audiograms by April 15, 1982.
3. Provide adequate hearing protectors. Use of hearing protectors is not mandatory unless; a) 90 dBA equivalent is exceeded, or b), permanent significant shifts in the workers' hearing level are found.
4. A noise survey must be performed at least every 2 years.
5. You must also perform a noise survey within 60 days of any change that may affect the workers' noise exposure. Such changes might include process changes, equipment changes, or personnel assignment changes.
6. Employees must be informed of measurement results within 21 calendar days. Employee representatives are to be permitted to observe the monitoring.
7. Provide information and training materials for workers.
8. Keep written records of noise exposure measurements. Include name of name of worker, job classification, date and location of measurement.
9. Maintain exposure measurements for 2 years.
10. Maintain audiometric test records for the duration of employment plus 5 years.
11. Maintain data on audiometric calibration and background sound pressure levels in test rooms for 5 years.
12. Post warning signs.

Permissible Exposure Level Equaled or Exceeded

1. Use of hearing protection must be enforced.
2. Offer a variety of hearing protectors. Train the workers in care and use protectors.
3. Engineering and administrative controls must be instituted if feasible.
4. Prepare a written compliance plan.